Space Weather Technical Forecast

Issued on Friday, 22 December 2023 at 12:56 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares throughout. Chance of Active fluence Days 1 and 2 (22-23 Dec).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate with an M3.3 flare peaking at 22/0004 UTC from AR3519 in the southwest quadrant. AR3519 has been the main source of recent flare activity, but is now approaching the southwest limb and as such is becoming difficult to analyse. There are currently five regions on the disc which are of reasonable size, but none have significant magnetic complexity with AR3529 losing its beta-gamma magnetic layout. There are a further five regions which are all small and simple at present.
The M3.3 flare from AR3519 produced a CME, which has been assessed as non Earth directed. No further Earth directed CMEs have been seen in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds have been at background levels through the last 24 hours. Wind speeds varied between 320-380 km/s. Density has been mostly below average. Total magnetic field strength, Bt, has been weak at 6nT or below. The north-south component, Bz, varied weakly between +/-5nT. Phi angle has been mainly positive (away from the Sun). Total geomagnetic activity has been Quiet (Kp 0-1) throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux has been at moderate to high levels, with a peak of 1290 pfu at 22/1050 UTC. The 24-hour fluence started well below the Active threshold (1e8 integrated pfu) but has been steadily rising. Fluence at at 22/0000UTC was 6.28e7 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Low activity is expected, with a continued chance of M-class flaring, mainly from AR3519. As AR3519 rotates off the disc on Day 2 (23 Dec), the risk reduces a little for Days 3 and 4 (24-25 Dec).

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are currently expected. The solar wind is currently at background levels. The high speed stream from coronal hole 83 may then connect with the Earth today (22 Dec), but this is now considered unlikely to occur. If it does it is likely to be weak, with wind speeds potentially reaching 400-450 km/s before declining again through Day 3 (24 Dec).
Geomagnetic activity is expected to remain largely Quiet to Unsettled (Kp 0-3) during the period. There is a slight chance of Active (Kp 4) intervals, should any connection to the high speed stream from CH83 occur today.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is at background levels and expected to remain at similar levels. There is just a slight chance of solar radiation storms, should there be any larger flares on the western side of the disc. High energy electron flux is expected to remain at moderate or high levels, perhaps declining slightly later. There is a chance of the associated electron fluence reaching the Active (1e8 integrated pfu) threshold on Days 1

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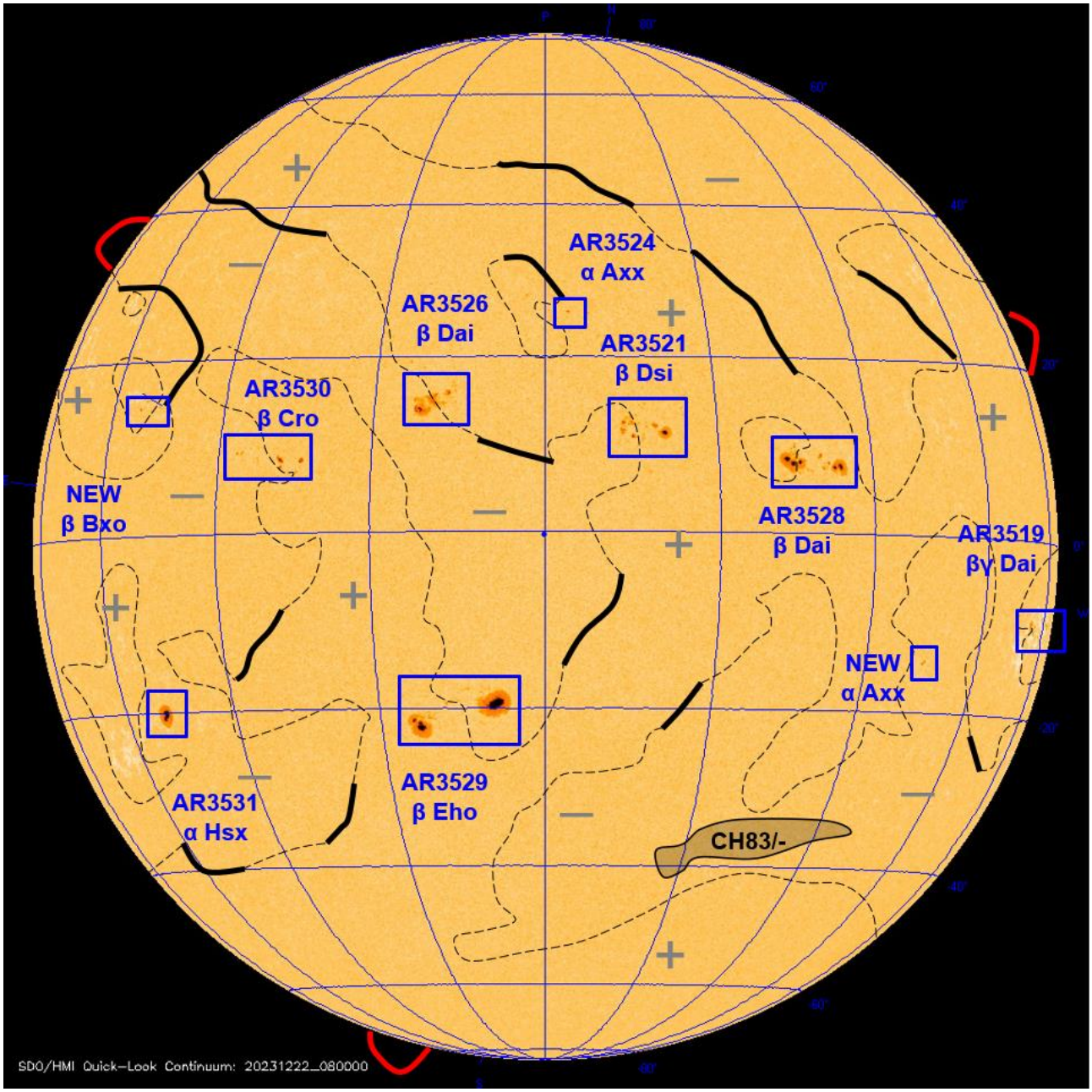
and 2 (22-23 Dec), before a gradual decline is most likely.

Figure 1. Solar Analysis Valid 22/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs are currently expected.

The solar wind is currently at background levels, having left the previous high speed stream from CH82. The high speed stream from coronal hole 83 may then connect with the Earth today (22 Dec), but this feature is quite a way south and appears weak in imagery. Therefore any connection is now considered unlikely to occur. If it does it is likely to be weak, with solar speeds potentially reaching 400-450 km/s before declining again through Day 3 (24 Dec).

Geomagnetic activity is expected to remain largely Quiet to Unsettled (Kp 0-3) during the period. There is a slight chance of Active (Kp 4) intervals, should any connection to the high speed stream from CH83 occur today.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth directed CMEs are currently expected.

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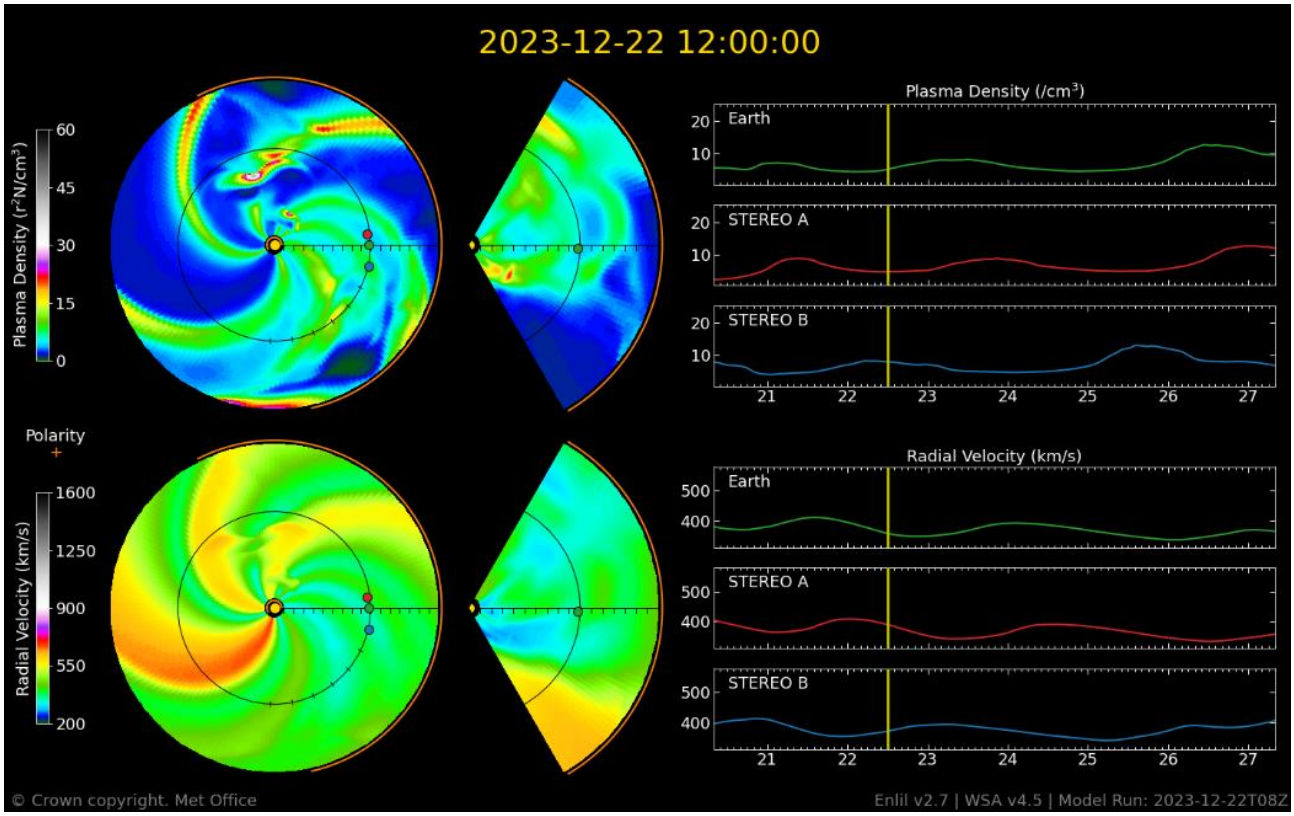
Figure 2: MOSWOC Enlil, with no Earth directed CMEs. Enlil's wind speed forecast shows near background levels through the next few days, which is considered reasonable.



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Radio Blackouts - X-Ray Flares:
There are currently ten regions on the visible disc. AR3519 (Dai/Beta-Gamma) has been the main source of recent flare activity, but is now approaching the southwest limb and as such is becoming difficult to analyse. There are currently five regions on the disc which are of reasonable size, including AR3519, plus AR3521 (Dsi/Beta), AR3526 (Dai/Beta), AR3528 (Dai/Beta) and AR3529 (Eho/Beta), but none have significant magnetic complexity with AR3529 losing its beta-gamma magnetic layout. The remaining five regions are all small and simple at present.

There is an ongoing chance of isolated M-class flares, mainly from AR3519. As AR3519 is currently the most active region and is due to rotate off the disc during Day 2 (23 Dec), the probability of M-class flares decreases slightly from Day 3 (24 Dec).

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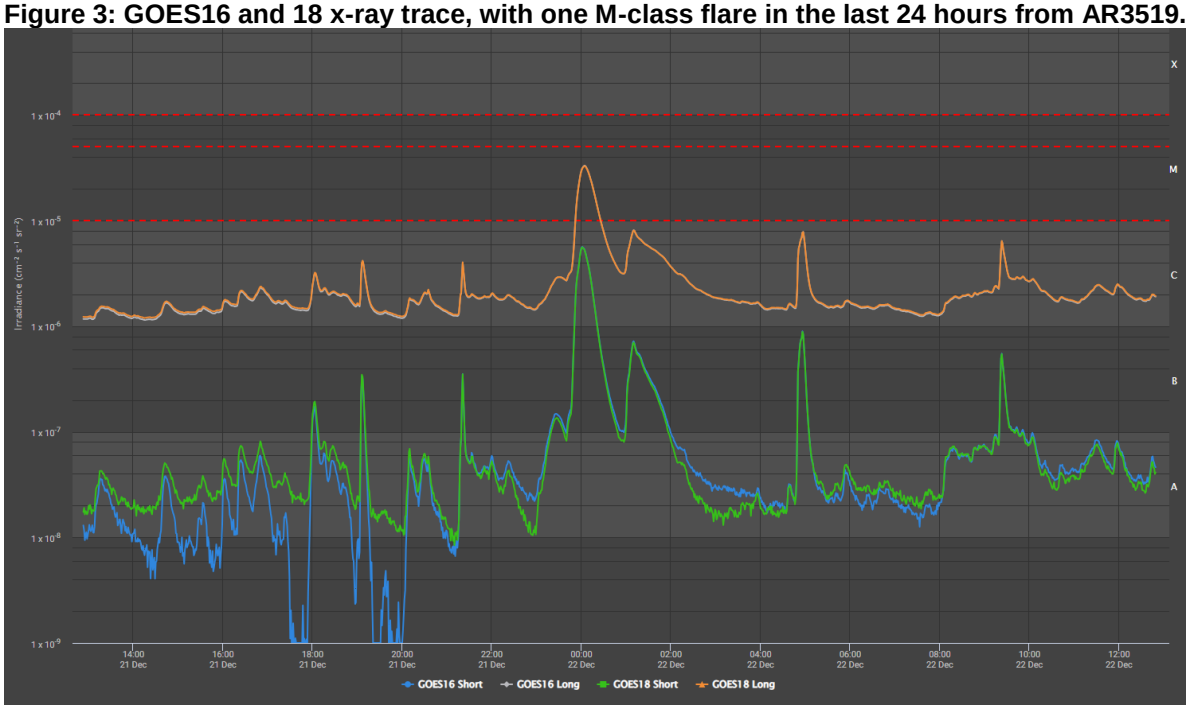
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES16 and 18 x-ray trace, with one M-class flare in the last 24 hours from AR3519.



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is at normal background levels and is most likely to remain at similar levels. However, there is a slight chance of minor solar radiation storms throughout, initially from AR3519 before it rotates behind the southwest limb, but also from the regions currently in the eastern hemisphere as they rotate into a more geo-effective position.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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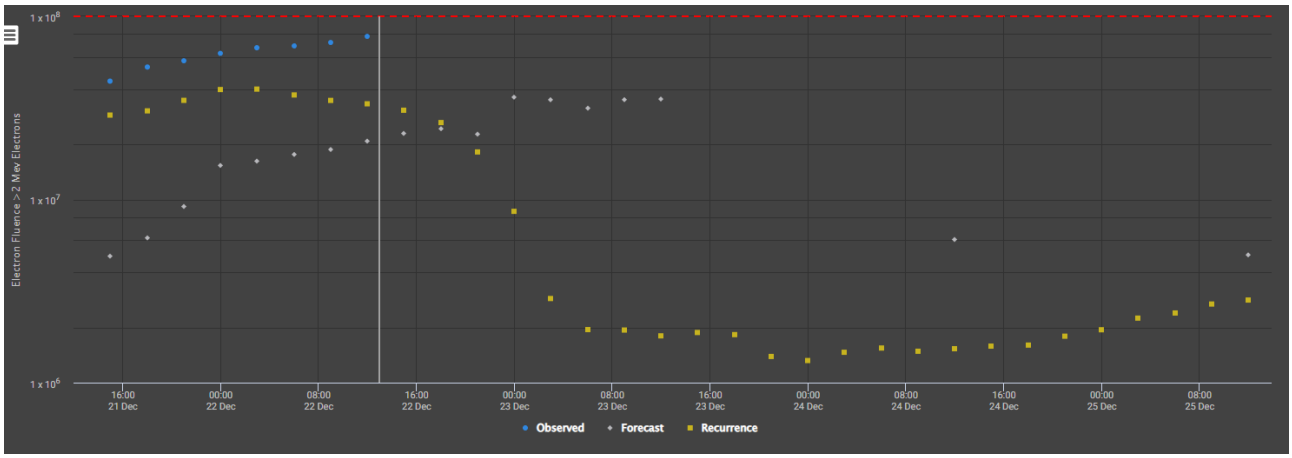
High Energy Electrons Event (≥ 2MeV):
High energy electron flux has been reaching just above the high threshold (1000 pfu) at the diurnal peaks. Any high speed stream from CH83 is now considered unlikely to occur, or at least to be very weak, and as such suppression of electron counts from this is not expected. The electron flux is therefore likely to continue at moderate to high levels in the wake of the recent high speed stream, but with no further fast winds or geomagnetic activity expected, this is unlikely to increase significantly either. The most likely scenario is now considered to be similar conditions for the next couple of days, followed by a slow decline for the following couple of days.

The associated electron fluence is currently close to the Active (1e8 integrated pfu) threshold and is likely to remain so at first, with some uncertainty as to whether it will just rise above or not. MOSWOC REFM is currently underestimating the fluence and does not appear to be providing good guidance. Overall, there is a chance of fluence reaching Active levels on Days 1 and 2 (22-23 Dec), this risk declining through Days 3 and 4 (24-25 Dec).

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	50	50	40	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM is currently under-forecasting the fluence, with near Active fluence levels considered possible in the next two days.



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